NOTE—Owing to the failure in the dispatch of the copies of this Address printed in England, by the vessel for which they were delivered, it has been necessary to have a limited number printed in Winnipeg from uncorrected English proofs. It is hoped that the copies printed in England will be available for distribution on August 30.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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ADDRESS

TO THE

AGRICULTURAL SUB-SECTION

BY

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CHAIRMAN OF THE SUB-SECTION.

The occupant of this chair, in the great annual convention of the promoters and appliers of science, cannot fail at the outset of a new session to put on record his emphatic endorsement of the claim, so strongly and so reasonably pressed by his distinguished predecessor at Dublin, that distinctively agricultural problems, instead of being regarded as a subsidiary sub-section of any single division of the Association, should be accorded the full dignity and convenience of a 'Section.' Specialised search is to-day one of the governing features of scientific inquiry. It is but fitting, therefore, that those who are trying to equip the agriculturist with all the knowledge which recent speculation and experiment have to offer for the fuller and more economic development of the soil should at least be allotted equal space and sectional rank with the engineer, whose problems are discussed

in Section G, or with the schoolmaster, whose educational methods are debated in Section L.

If there were any country in the world where an apology could legitimately be offered for relegating agricultural science to a secondary position, it is certainly not that in which we meet to-day. In this wide Dominion of Canada, in this progressive province of Manitoba, in this great city of Winnipeg, where the agricultural industry must dominate the interests of the people, hardly any subject in the whole range of study can claim a more paramount degree of attention than the utilisation of the land for the use of man.

This is by no means a matter which can be disposed of as an occasional side-issue in the deliberations of any single Section. If we agriculturists have been tardy in coming to be taught by the scientists, we are in earnest now in the application for instruction that we make. Neither is it to any one science we appeal. Even the stern mathematician or physicist of Section A can teach us something, arithmetical and meteorological, for the right conduct of our business and the wiser forecasting of our plans. The chemists of Section B have, in an infant variety of tasks, to come to the aid of the farmer, and they have doubtless much to tell of the magic they can promise in the direction of fertilising methods. Section C must be raided for the experts who know the contests of the soil itself and its capacities. Section D may have much to pass on to us concerning the live stock and the insect enemies of our farms. Section E may enlighten us on the world-wide distribution of crops and the new regions awaiting the skill of the husbandman. To Section F we look for warnings as to the economic conditions and barriers which—as we are apt to forget—hedge round our industry, and for the statistics which must govern the varying direction which we give to our enterprise from time to time. The mechanical operations of our calling suggest to us the practical assistance which Section G can surely offer. Nor does even Section H lie wholly remote from the inquiries we may need to make as to the resources of the globe and the wants of diverse communities. The physiology of Section I opens regions of research quite germane to many of our daily studies. Under Section K, as an overlord, we rest to-day assured that if every botanist is not a farmer, every farmer must in a sense be a practical botanist, for ever face to face with the plant and its environment. Perhaps, also in common with all the rest of the world, we may have something to our advantage to hear from the pedagogues of Section L, who may advise our scientific counsellors as to the best form in which even the practical farmer may be taught.

Addressing ourselves, however, to the immediate task in the subsection allotted to us, I suggest to you to-day that, having regard

to the place where we meet, I may, as a proper prelude to your debates, invite you to consider, even if only in the broadest way, what are the leading factors that govern the fluctuations of this our industry of agriculture all the world over, and in new countries in particular. The first factor of all is undoubtedly population—its growth its rapidly varying local distribution, and its changing and diversified needs. It is for man that crops are raised, whether these crops are to furnish food for direct consumption or for the sustenance of live stock, or whether they furnish us with our clothing, like the wool and the cotton of other lands, or with the materials for shelter, as the great timber crops which your vast forests here may bear. When we know what is the demand at any given place and time, we shall be prepared to give a more exact examination to the means of turning out the effective supply at the right moment and in the right place, be it of wheat, of meat, of fruit, of wool, of flax, of cotton, or of timber.

Sir Horace Plunkett told us last summer that he hoped to find in an Agricultural Section 'some humanised supplement to the separated milk of statistics.' Perhaps he unconsciously reflected in that remark the suspicion that in earlier days the agricultural debates, which, for want of a better place, took place in the Economic and Statistics Section, unduly paraded the bare figures of the position. But I myself confess that, however mortals may shrink from the rigid arbitrament of arithmetic, neither the teaching of the scientist nor the rhetorical advice of the philosopher will lead the agricultural student of the future, even if he have the luxury of a complete Section of his own, to any fertile result, unless he begins by a clear diagnosis of the facts as they stand, on the one hand as regards population, on the other as regards production. We shall by no means waste time if we try to investigate, with some approach to exactness, what are the areas still available for extended cultivation, and who and where are the consumers of our products, and what are their present and future demands.

Obviously, however, in the limits of an Address like this it is impracticable to make, in any detail, a world survey such as this implies, and it is only the most patent of the changes in the world's populations and their agricultural demands which I can put before you. There was a time when the human family lived in self-contained groups, extracting their requirements from the soil which lay around them. So lately as one hundred years ago there was very little of the international trade in food or other agricultural products such as is familiar to our practice to-day. The nations largely lived on their own territories, and the world has wide sections still where production is limited by local needs. But even a hundred

years ago or more perpetual questions were emerging as to the time when men should have multiplied more rapidly than food. The transportation revolutions of the nineteenth century may be almost said to have laid that scare by their aid to the mobility alike of the world's populations and of the world's produce. For the migration of men from dense settlements to open lands, and the transport of their produce to the cities of the old world on the other, have simplified, and may simplify still further, the solution. It is all a question of distribution.

If the world holds to-day just twice as many souls (as the best demographic authorities seem to assume) as it did only some two generations back, this growth has been by no means uniform, and the development is governed and provoked by the pressure of population on sustenance. Sometimes, I think, we are apt to forget what Professor Marshall, of Cambridge, has so well laid down, that 'man is the centre of the problem of production as well as that of consumption, and also of that further problem of the relation between the two which goes by the name of distribution and exchange.' Vastly has the latter problem been simplified by the giant strides the second half of last century has seen in annulling distance and in facilitating transport, till all the world bids fair to become a single community. Whether the present distinguished British Ambassador to the United States was right in looking forward to the gradual unification of the type of the world's inhabitants by the diverse processes of ultimate extinction and absorption of inferior races, I think we will agree with him that the spread into new regions of conquering or colonizing races has provoked desires for, and made practicable the supply of, far more varied wants than once were even contemplated, or could indeed have been made available, while the producing areas were sundered widely from the consuming centres.

The sixteen hundred million souls this earth of ours now carries are at present by no means evenly spread over its surface, and a population chart reveals the most extraordinary diversity in the density of the people on the soil. More than one-half are on the continent of Asia, and of these a large section are densely clustered in India, China, and Japan. In Europe, where the average density is double that of Asia, and approximately one-fourth of the world's inhabitants are gathered, many portions are nevertheless still far less thickly peopled than the Eastern States just named. Populations, over any considerable areas, exceeding 500 to the square mile may be found on the world's map not only in parts of the United Kingdom, in Belgium, or in Saxony, but yet again on the Lower Ganges, on the Chinese coast, and even in portions of the narrow

valley of the Nile. But the Indian or the Chinaman are not, broadly speaking, to be ranked among the communities of which we are thinking when we concentrate our attention on the increasing transport of breadstuffs or of meat from the New World to the Old, which has become the prominent feature of the agriculture of our own day, whatever attention may have to be given to the conditions of the Far East at some distant date.

The great movements of agricultural products which have signalised the last half-century are not for the most currents of food supply into Asia, or into Africa, or North America, despite certain limited exceptions which are just beginning to attract attention, as possibly hereafter signified in the case of imports of wheat into Japan or China, of Australian meat into Eastern Asia and South Africa. The Asiatic or the African agriculturist is for the most part content to find the primary necessities of life close at hand. It is mainly Europe, and indeed Western Europe, that calls to-day for the import of breadstuffs or meat or dairy produce, and the growing volume of sea-borne imports has not only materially influenced the agriculture of old settled countries, but at the same time has signalled to the European toiler that space and plenty awaits him oversea, and has stimulated the development of new spheres of cultivation at a rate which the relatively sparse population of the New World, unless largely recruited by immigration, could never accomplish.

I ventured some years ago, from the chair of the Royal Statistical Society, to review the recent changes we have seen in the structure of the world's populations, and urged the greater wisdom of bringing the men to the food rather than the food to the men. The centripetal force which was, in all parts of the earth and not in the oldest countries only, packing more and more together the human family in vast industrial centres, which drew the materials of their handicraft and the food for their maintenance from far distant lands, seemed to my judgment a much less healthy form of development than the older centrifugal impulse which led man to move himself to the newer regions, where the produce was nearer to the mouth of the consumer, and where he could fulfil the oldest obligation of the race to go forth and replenish the earth and subdue it. The vision that meets us here of ample land awaiting man, of possibilities of agricultural production which can only be realised by well-considered and augmented immigration, impresses the visitor from an old and overcrowded country. Before and above all speculations of what transport has done, and may yet do, to carry masses of agricultural produce across the ocean, I must claim as the better prospect a steady settlement of these wide acres by a popu-

iation resting on the soil which this great Dominion offers, and drawing from it, by a more diversified and more general and more wholesome type of farming, a far better, and in the long run a more economic, return than the mere extraction of grain for export can ever promise.

Taking the thirteen States of Western and Central Europe as an example of what I mean, there were added there, in the last seventy years of the nineteenth century, on a comparatively limited surface, something like 100,000,000 new consumers to the 167,000,000 persons previously resident on the 1,700,000 square miles of territory occupied by this group of nations. These numbers, too, take no count of the emigration which has lightened the pressure on the soils of the home lands of Europe. Clearly the maintenance of nearly 70 per cent. more consumers must have meant either a vast development of local agricultural production or a vast demand upon the acreage of the new land of the West, or both. The defective nature of the early statistics obstructs the search one naturally makes into the extent on which these new populations on the old land have been fed on larger local areas, or from larger yields on non-expansive areas. Adopting, therefore,a much shorter range of view, the lifetime of a single generation has given us 30 per cent. more consumers in Western and Central Europe than were there in 1870, the German element rising apparently by 50 per cent., the Scandinavian, Belgian and Dutch group of small nationalities by 44 per cent., and the United Kingdom by 40 per cent. in this interval, while these developments were of course reduced in their effect on the total by the slower growth of the Southwestern nations and the nearly stationary condition of France.

No larger areas, but rather smaller ones, of the chief food grains are apparent in Great Britain or Scandinavia or Northwestern Europe. The German areas of wheat and rye show practically little change, and although, if the Hungarian areas are larger in the centre of Europe, the general movement is not upward in respect of food-producing area. Even in livestock the numbers scarcely keep pace with population, for although the herds and the swine of Western and Central Europe have risen by nearly a fourth in the one case and three-fifths in the other, the sheep, except in Great Britain, are much fewer now.

On the average of the first quinquennium of the present century the home production of wheat represented only about 20 per cent. of the consumption in the United Kingdom or in Holland, 23 per cent. (apparently) in Belgium, 64 per cent. in Germany, and perhaps 80 per cent. in Italy; and the imported grain to fill the deficits was considerably over 400,000,000 bushels. Nearly half of this came, of

course, from Eastern Europe, and particularly Russia. Such a mass of produce would require 20,000,000 acres elsewhere, even if the exporters could raise it, as most have certainly not done, at twenty bushels per acre, and nearly double that area if the yield was only that of some of our largest exporters to-day.

The actual reductions of area in Western Europe are not in the aggregate extensive, although Belgium has seen her grain area shrink from 30 to 25 per cent. of her total surface, France from 28 to 25.5 per cent., and the United Kingdom from 12 to 10 per cent. The grain-growing capacity of European States varies greatly, and it would be interesting, were the data everywhere available, to see how far we have distinct evidence of an appreciable if not any great advance in the yields extracted from the non-expanding areas under the more recent conditions of scientific knowledge. Nowhere is so large a share of the total surface under grain as in Roumania, an Eastern European State and not inconsiderable wheat exporter, and there, at all events, the total grain acreage developed between 1885 and 1905 by nearly 25 per cent., and the surface under wheat by 72 per cent. The yield there, according to some official reports, was something over 15 bushels per acre in the five years before 1890, and in those ending 1906 it was over nineteen bushels—the latest year nearly touching twenty-three bushels; the barley yields of the same State rising from an average in the former quinquennium of thirteen bushels to over nineteen bushels in the latter.

In Hungary, another European grain exporter, the wheat acreage has been materially developed, rising from over 7,000,000 acres to 9,500,000 in twenty years to 1906, and but slightly receding since, while the yields are also materially greater.

France, with a drop in wheat acreage of 1,000,000 out of 17,000,000 acres, has between 1884 and 1908 raised the average of her production on a five years' mean from 17.8 bushels to 20.2 bushels and thus turned out somewhat more produce from a lessened surface.

Germany, on a constant but much smaller wheat area of 4,700,000 acres, with a quinquennial average yield of 20.3 bushels, would seem to have raised this to 27.9 in 1899-1903, and touching a still higher level in more recent seasons, when 30 bushels were apparently approached, although some changes in her statistical methods of inquiry may slightly reduce this comparison.

Some effort to feed new mouths from old acres has thus indeed been made. Nevertheless, without disregarding altogether the qualification which a careful statistician would deem it his duty to admit, one may broadly say Western Europe looks mainly for the

growing needs of her consumers to the New World regions of North and South America, and in a minor degree to Australasia.

Before we quit our session here in Winnipeg, we may expect to learn something of scientific interest and of economic guidance respecting the response of Canada to the Old World's call. But it is not for grain alone that densely peopled countries turn to the new fields of the West. Probably the geographical conditions of our place of assembly this year will not lead us at all closely into discussion on the variations in the sources and fluctuations in the volume of the wool supply, or that of cotton, but the possible development of livestock on the territories of newly settled countries may be expected to come well within our purview, and afford us lessons in the development of the export trade in meat and dairy products, and the relation of the Canadian to the surplus of other States. The Royal Statistical Society of London had a paper this summer by an old colleague of mine, Mr. R. H. Hooker, which, although primarily devoted to the supply of Great Britain herself, and the price of meat in her markets, has a world-wide view of what is going on all around us in the conditions of production and of transport in a community as important to human life as wheat itself.

Fully a quarter of a century has gone by since, on a former visit to Canadian soil at Montreal, in 1884, I raised a debate on this subject of the production and consumption of meat, and the various conditions of its transport. The twenty-five years that have passed since then have not rendered that particular topic a less important one for the consumers of old countries or the farmers of new, but ever-varying factors are presented by the opening of new territories to exploitation and the denser massing of accumulated populations with growing needs, and increasing preference for the most concentrated form of aliment. Among the most recent factors to be remembered as influencing one side of the meat trade future are the admissions of qualified experts in the United States as to the degree in which the growth of population there was beginning to trench upon the meat surplus of that Republic. On the other hand, the producer will not fail to bear in mind the rapidly advancing importance of partially developed areas and the great advantage of the more economic forms of dead-meat transport now adopted in South America, and will weigh against these the degree in which the herds of the vast prairies of North-Western Canada may be further utilised when questions of handling economically the resultant meat supply may be effectively elaborated.

To-day, however, and here especially, one cannot but be reminded that in whatever direction we look for the aid of science to stimulate the development of Canadian resources or to help the producers now in these provinces in measuring the probabilities that lie

before them, or to summon eager immigrants to the land you have to offer them, there is an intense and ever-ingrossing interest in the present and the future of wheat. Alike, therefore, to the statistician and economist on the one hand, and to the experimentalist and investigator on the other, we turn to ask what advice they can give to a new country with a superficial area so vast as the North-West of Canada presents, whether and how far and at what rate, with profit to himself and with benefit to the bread consumer across the ocean, he can push the extension of the well-nigh eight million acres of wheat land which the Dominion claims to show her visitors in 1909.

The problem, important as it is to this particular region where we are met, cannot, however, rightly be treated as a purely Canadian question. It is a problem of world-wide interest and of great magnitude and more complexity than has been sometimes recognized, for it is none other than the issue of the race between population and production so far as at least one primary essential of human diet—bread—is concerned.

Within a year of the last visit to this Dominion of the British Association, the question was raised by no less an authority than the then President of that body, at the Bristol meeting of 1898, whether the possible wheat fields of the globe possessed a potential capacity of expansion sufficient to meet the hypothetical needs of the bread-eaters of even one generation ahead; whether, in fact, a dearth of wheat supply was not already within sight, and by 1931 would be upon us. The suggestion that the wheat-producing soil of the world was already becoming unequal to the strain put upon it by the multiplication of men was not unnaturally met by a vigorous criticism. The mere suspicion that some day, however, there would not be land enough to go round, that famine could be averted only by the beneficial magic of the chemist, is too vital a possibility—even if some of us do not place the date so near or rely so fully on some of the computations made—not to command a very careful examination of the remedy propounded, the promise of the artificial production of nitrate in such a volume and at such a price as would raise the average of the world's production from 12.7 to 20, if not even to 30 bushels of wheat per acre.

The fixation of nitrogen, not as a dream but as a certainty, was, it will be remembered, claimed by Sir William Crookes as the condition on which the great Caucasian race was to retain its prominence in the world, and avoid being squeezed out of existence by races to whom wheaten bread is not the 'staff of life.'

Personally, I confess I am not so pessimistic as to the surface still available for wheat-growing even without this aid. If we grant

that the so-called contributary areas, at a date two or three years before the close of last century, were just what was then stated, that the bread-eating population of that date was rightly guessed at 516,500,000—a much more difficult certainty to reach in the manner adopted by the American statistician whose figures were adopted —and that both the growth of population and of 'unit consumption' would proceed exactly in the ratio suggested, it may legitimately be asked, does it nevertheless follow that no such increment of area can be looked for as would satisfy the larger mass of consumers calculated for as likely to be dependent upon wheat in 1911 or 1931 on the scale here laid down?

I should not, in any statistical investigation into these questions, be contented to assume the probability of the exact continuance of previous ratios in the rate of production, or that of individual consumption over such periods, and my experience of very big averages makes my shy of adopting a simple mean of such wide diversities as correctly representing the head-rate consumption of wheat. These are points which might be more fittingly debated elsewhere. I want to narrow the issue now to the actual and more recent course of the wheat-growing surface; for it seems to me that the lesson of such figures as we have in the past, and as those of Mr. Wood Davis's tables, is rather one of irregular than of arrested extension. The periodical opening up of new areas, very often in advance of the consumptive requirements of the time, would seem almost invariably to be followed by a pause while prices recover from the over-supply, and that again by new developments and exploitation in new directions, or by better methods on the areas made tributary to the wants of the ever-increasing men.

We may admit that the course of the wheat acreage from 1870 to 1884 and thence onward to 1898 showed—first, a material advance outstripping that of population, then an admitted and serious check, with a subsequent advance, although one below that of the bread consumers of the world.

Let me ask, however, if a later view of the wheat area at the disposal of the world's consumers is not well qualified materially to diminish, if not to dissipate, the 'cosmic scare' which, no doubt contrary to the real design of the distinguished chemist who followed Mr. Davis's estimates, was induced by the figures of 1898. My own comparisons of the later growth of acreage covers only the decade from 1897 to 1907, or as nearly to these years as figures permit, and in the form I originally designed it might bring into view something under 230,000,000 acres as the world's present extent of wheat-field. But, to place matters on a more comparative level, I am willing to

omit the large Indian totals and some few of the distant regions which, partly on account of the somewhat uncertain identity of the areas they include at different dates, and partly on account of their relatively small contribution to the bread of the Western world, do not find a place in the estimates with which I am now making a comparison. For the leading groups of other areas the figures stand in millions of acres to a single decimal:

Groups—	1897	1907	Increase in 10 years.
Russian Empire	46.6	59.5	12.9
United States	39.5	45.2	5.7
Three chief European Wheat States	37.6	39.8	2.2
The rest of Europe.....	20.8	21.4	.6
Argentina and Uruguay	6.7	15.0	8.3
Canada	3.0	6.6	3.6
Australasia	5.0	6.0	1.0
Total	159.2	193.5	34.3

Now, whatever be the estimated increase in wheat-eating population between these two dates, it cannot in the aggregate be 21½ per cent., as is the growth of the wheat surface in these States. Nor will the result be materially affected if allowance were to be made for the three or four million acres represented by the exports of unnamed States in this table, or even by the inclusion of any minor units of wheat-growing, such as Portugal, or Greece, or Switzerland, for which Mr. Wood Davis estimated from sources not recognised in our official statistics, their totals being well under a single million acres, and the variation, if any, probably insignificant.

If, therefore, the growth of men outstripped the growth of wheat, as we have been warned was the case between 1884 and 1897, the growth of wheatfields has been well over the rate of population increase since that exceptional period, just as it was in the still earlier period between 1871 and 1884. Nor is the check to the rye acreage and its decline by 4 per cent., which seemed to have happened concurrently with the wheat check between 1884-1897, continuing; for that, in the aggregate, seems to have returned to, though it has not perhaps much exceeded, the older level.

Comparisons at single terminal points have always a danger which may be avoided by examining more carefully the leading facts year by year. On the diagram which I introduce here* I have tried, therefore, roughly to sketch the curves which indicate the growth of wheat acreage, both before and since 1898, in Russia, the United

*It has been necessary to omit the diagram from copies printed in Winnipeg.

States, Argentina, Australia and Canada. as typical of the exporting centres, while the acreage in France and Hungary has been added for comparison. The effect is, I think, to bring out the very much greater extension which has been going on during the last decade than could well have been looked for on the basis of the 1884-97 figures.

For the Russian Empire as a whole data are available only since 1895, but I have shown by a separate and steadily mounting line the wheat area of the fifty governments of European Russia, which are comparative for the entire period, and the latter are quite sufficient to establish my conclusion. There is, too, a suggestiveness about the course of prices (in shillings per quarter) in England, the chief recipient of wheat exports, which I have traced by a separate curve across this diagram. This may perhaps aid those who are disposed to make a closer study of the figures. That study may not improbably suggest that in the very latest year—for I have carried the diagram to 1908 where I can—we may be once again nearing another check, or temporary halt, in the course of wheat extension, such as that which puzzled inquirers more than ten years ago, but which proved only a pause in the task of finding all the bread the consumers wanted under the stimulus of better prices. The further leap of prices in 1909 to beyond the 40s. limit in England may effectively encourage extension.

The exceptional arrest of wheat-growing in the United States between the years 1880-1896, when—if we may accept the official statistics as actually representing fact—the rapid rise, which actually doubled the wheat acreage between 1870 to 1880, stopped altogether, was, I believe, the prepondering factor which suggested a general halt in wheat-growing. It should therefore be looked at more closely, and to get rid of the danger of attaching too much importance to the data of single years, the quinquennial average movement in the States over the whole of the last forty years may be summarised as under:

Five-year Periods.	Acreage U.S.A. Acres.	Distinctive Wheat Acreage Levels.
1868-72	19 500,000	Extending rapidly up to 1880
1873-77	25,500,000	
1878-82	35,500,000	Nearly stationary from 1880 to 1896
1883-87	37,000,000	
1888-92	38,000,000	
1893-97	35,500,000	Again extending to maxima reached in 1901 and 1903, with a later slight decline in the latest years.
1898-1902	45,500,000	
1903-1907	46,800,000	

Population in the States has, of course, augmented steadily all over the forty years, from 37,000,000 to 86,000,000, yet all through the

stationary as well as the advancing years exports of wheat and flour continued, as much as a third of the crop being shipped abroad in some years, and the transfer of the wheat lands northwestward in the States was doubtless the striking feature of the recovery. Rightly to understand the revolution in the wheat-growing of certain States of the Union would require a treatise for which time could not be given here.

Let me, however, recur again to the general position. In the table already given for the past decade the latest increase to be accounted for is 34,000,000 acres, and ask you to note that the Russian quota becomes more than a third of the whole. Now it was Russia that was in a very special degree the subject of unfavorable remark in the wheat problem controversy of ten years ago. She was spoken of, I remember, as having reduced her consumption of bread by 14 per cent., and only by this means continuing her exports in defiance of her true needs, and contributing to the rest of the world therefore a merely provisional and precarious excess. I am not aware how the calculation here alluded to had been arrived at, nor have statisticians perhaps a very robust faith in the estimated numbers of the Russian population before the great census of 1897, but the subsequent history of her apparent wheat surplus is interesting.

The exports of wheat from Russia, which we were warned could not continue, and which had doubtless been unusually large between 1893 and 1898, shrunk for three years after that date as if they would realise the prophecy which would relegate Russia from the ranks of exporters to the task of feeding her own population. But that mysterious empire has since then resumed her large supplies, and from 1902 to 1906 the exports ranged higher than before. Although forming only 24 per cent. of her estimated wheat crop, Russia's exports averaged 141,000,000 bushels over the first five years of this century, against 104,000,000 bushels over the whole preceding fifteen years. Quite lately we seem to have seen some restriction, but the history of the trade forbids a confident opinion that she has reached the end of her contributions to other lands.

So far as the areas under wheat are recorded, the Russian agriculturist keeps on extending his industry, and, low as the yields may frequently be, they are tending upward under, it may be presumed, some reform of the very primitive conditions of production. Within the fifty governments of European Russia alone, and omitting the Polish or Caucasian figures, which do not go so far back, the average area of 29,000,000 acres only in the eighties became 40,000,000 at the close of the century, rising to a maximum of 49,000,000 acres in 1906, a point from which a decline was shown in 1907 to 45,600,000

acres. This, however, even taking the latest and lower figure, is an advance of 10,000,000 acres in the last decade, or nearly 30 per cent.—surely considerably in advance of even the Russian growth of population, great as that is.

It has, I think, not been sufficiently realised that in the two decades stretching from 1887 to 1906, European Russia has added 1,000,000 acres of wheat per annum. This is not only a 70 per cent. advance in twenty years, but it is double the absolute area of 10,000,000 acres which the United States added in this interval. From such official estimates as are furnished, the total produce of these fifty governments, where alone the figures are continuous, increased in a still higher ratio. The average production, which did not exceed 180,000,000 bushels in the five years before 1879, or 226,000,000 bushels in the quinquennium ending 1889, reached what appears to have been a maximum in 1904, and was averaged at 415,000,000 bushels for the whole five years' period then ending. If the later years are again at a lower level, they represent very nearly double the produce before 1879. The yield per acre, which stood below eight bushels to the acre between 1883 and 1892, averaged nine bushels over the next ten years, and has been 10.9, 10.4 and 11.4 bushels, respectively, in the three seasons ending 1904. In the southwestern region, where the yield was just over eleven bushels in the decade ending 1892, it seems to have averaged fifteen in the ten years ending 1902, while over eighteen and nineteen bushels were reported in 1903-1904.

These figures omit the Polish, Caucasian and Asiatic districts, for which a much smaller retrospect is possible. The acreage in Poland is small—little over a million—and nearly constant in extent. But the wheat of Northern Caucasia, first accounted for in 1894, has risen from 5,600,000 acres to 8,300,000 in 1906, and the Siberian totals, after increasing, apparently but slightly, from 3,400,000 acres in 1895 to 4,800,000 acres at the close of the century, do not seem much to exceed 5,000,000 acres now. Russian wheat production does not therefore seem a wholly arrested process.

I own I was hardly prepared for this old nation's progress in wheat-growing, and I have no doubt that I shall be told that Russia has been exchanging one form of bread corn for another; in particular, that dependence on rye has decreased as production of wheat has grown. There is some truth undoubtedly in this, for the comparatively stationary character of the rye area indicates that the Russian people, increasing as they are and continuing still an export of rye to Germany and elsewhere, may themselves eat somewhat more wheat and rather less rye, and it is true also that a fluctuating record has attended the surface under the coarser and larger cereal crop. Its 'low-water' point—61,900,000 acres—occurs in 1893, while its present

figure is 66,000,000 acres. Relatively, therefore, while the rye shows no progress such as wheat, it cannot be said that the rye area has been utilised for the more valuable cereal, and the fact remains that there is more rye grown to-day, even in European Russia, than at any date since the last decade of last century began.

Inquiry shows that the wheat extension in Russia has been made possible by an actual addition to the arable land, and not by deduction from other crops. A recent investigation quoted by a competent American authority informs us that some 23,000,000 acres of new arable land has been accounted for between 1881 and 1904, and, moreover, that a greater surface of this nominally arable area is now actually under cultivation than at the earlier date. These figures stand:

Year	Total Arable Land.	Under Crop.	Wheat.	Rye.
	Acres	Acres	Acres	Acres
1881	288,000,000	174,600,000	28,900,000	64,600,000
1904	310,700,000	205,900,000	45,600,000	65,600,000

It will be noted that this inquiry ends a year or two since, but had it been continued to 1906 the comparison would have been accentuated, and as it stands the additional area cropped in one way or another exceeds 31,000,000 acres.

In Mr. Wood Davis's later memorandum he combats the idea that the expected wheat crops from four relatively new areas of production—Siberia, Argentina, Australasia and Canada—would meet the shortage he found threatened by his estimate. Not unnaturally he regarded an 8,100,000 addition of acres in these four regions in fifteen years as a very insufficient and unpromising quota to feed over ten times that number of new bread-eaters on the globe between 1883-4 and 1898-9.

Assuming he rightly gave the increment of wheat between these dates as under, if I add to his table the latest data that I have, these new and gradually opening areas will show a rate of progress much greater in the nine succeeding years than before, even if there was no further increase in Siberia; for as to the areas to be included there I am certain. The figures I give in millions of acres:

	1883-84.	1898-99.	Fifteen years' increase.	1907-08.	Nine years' increase.
Siberia	2.0	3.3	1.3	3.3	—
Argentina	1.4	6.1	4.7	14.2	8.1
Australasia	3.2	4.5	1.3	5.6	1.1
Canada	2.4	3.2	.8	6.6	3.4
Total	9.0	17.1	8.1	29.7	12.6

In the forecasts offered ten years ago Argentina as a wheat-grower was given a dozen years from 1898 to reach a possible acre-

age of 12,000,000 acres. She has reached that figure and passed it in less than a decade, and some current official estimates seem to concede to that region a close approximation to 15,000,000 acres to-day. As the actual pace here again has bettered considerably that prophesied, one may legitimately question the further limitations which allowed to Argentina no prospect of ever reaching a wheat area of 30,000,000 acres at any time. That these phophecies by no means coincide with later and probably quite similarly vague forecasts in the other direction, goes without saying. In a recent official publication by the U.S.A. Government containing the report of an expert on the resources of Argentina and her farming methods, the competitive prospects of the great grain-exporting Republic of the South were scarcely so lightly treated. For my own part I rather agree with an officer of the Argentine Government there quoted (Senor Tidblom), who candidly admits that it was impossible with any accuracy to forecast the ultimate wheat area of Argentina, although I observe he adds that there were 'more than 80,000,000 acres in the Republic that could be immediately devoted to successful wheat-farming if we had the farmers to do it.' I have seen, though I could not accept, even more sanguine estimates in other quarters, which, with a yield of only ten bushels per acre, promised a crop of 1,238,000,000 bushels at some future date, and would involve an area of wheat land approaching 124,000,000 acres.

No one, I think, can note the strides which Argentina has taken in rapidly augmenting her wheat areas and exports, and that concurrently with the commanding place she is assuming as a meat rearer and exporter to the older peoples of Europe, without some recognition that a great future is possible. On the other hand, the climatic conditions, the nature of the Italian immigrants, their mode of culture, their non-intention in many instances to remain and own the land or identify themselves with the country—preferring to exploit one farm after another and reside on them until they make a small competence wherewith to return to Europe—are all reasons against the extremely favourable prospects which I have here adverted to.

Small relatively to the great extent of surface included in the Commonwealth of Australia is the proportion under wheat, but the Commonwealth is none the less as a rule an exporter. A little more than thirty years ago only about 1,400,000 acres were grown. This seems to have been a good deal more than doubled in the five years 1876-81, when a much smaller rate of increase followed for fifteen years—a check apparently reflecting the same tendency to arrest which we have seen so typically illustrated in the United States.

Again, after 1896, just as in the great Western Republic, wheat-growing became again in favor, and the rapid spurt which followed brought the Commonwealth total to 5,700,000 acres as the century closed. Thereafter the rate of growth seemed checked anew, and after passing a maximum of just under 6,300,000 acres, it stands to-day under 6,000,000 acres. Twice during the last twenty years has Australia shown on balance a net importation of wheat, but from 1903 to 1907 the quantity exported has averaged 36,000,000 bushels, and it is not without interest to observe that the Australian exports of the present century have not all been consumed in Britain, South Africa, the western coasts of South America, and even some parts of India sharing in the surplus product of the Antipodean Continent.

The conditions and the future of Australian wheat have been quite recently dealt with in an interesting paper by Mr. A. E. Humphreys, read before the Society of Arts in London. It is here pointed out that the soils on which it is grown are rich in assimilable nitrogen, requiring little manurial expenditure in that direction, but poor in their percentage of phosphoric acid, while the climatic conditions as regards moisture have proved remarkably difficult. Efforts have been made, and apparently, if recent experiences be confirmed, with success, to breed new varieties of the wheat plant adapted to the peculiar climatic conditions of Australia, and likely to increase the low average yields hitherto obtained. It is obvious that under Australian conditions the breeding of varieties of the wheat plant which will thrive on a low rainfall would make all the difference to Australia as a source of wheat exports. From 1902-1907 the Australian average yield was only half that of Manitoba, or nine bushels per acre; but this included one year of disastrous drought (1902-1903), wherein the Commonwealth average fell below 2½ bushels to the acre. In New South Wales and Victoria, wherein more than half the acreage lay, it was even below this according to the official figures. Such instances offer the strongest evidence that could be offered of the extreme variability of Australian conditions, and make one almost hesitate to quote Mr. Humphreys' own cheerful estimate that in the State of New South Wales alone, wherein nearly a third of the Australian acreage is found to-day, or 1,886,000 acres, there was a possible area of good wheat land of nearly ten times this, or 18,000,000 acres.

To the last I have left another sphere of wheat extension, and one that will be most of all familiar to my audience. Yet here again the forecast of the Canadian future made in 1898 was surely unduly pessimistic. The opinion then quoted by Sir William Crookes as that of trustworthy authorities assigned to the Dominion a bare total of 6,000,000 acres under wheat as all that could be expected to be reached

within a dozen years. That period has not yet fully come, but I observe that by December 31, 1908, the official figures show an acreage as reached within the decade which exceeds by 10 per cent. the maximum allotted to 1910. If I were to add the figure now ascertained for the 1909 crop, a total of 7,750,000 acres is now reckoned upon, so that here again the forecast has been outstripped. The further proposal to estimate the maximum of the Canadian potential capacity for wheat production by 1923 at no more than 12,000,000 acres will, therefore, I imagine, meet severe critics in Winnipeg to-day.

I greatly wish that our contribution to the knowledge of the economic future of Canadian development may be, as the result of discussions here, some approach to an agreement to avoid all exaggeration on the one hand or on the other in these forecasts of future wheat-growing in the Northwest; but I am very conscious of the risk of all far-reaching prophecy in a problem where the more or less uncertain growth of the immigrant population plays as great a part as the soil or the climate.

Sir William Crookes, in endorsing the most modest estimates of the capacity of this region, mentions that he had before him calculations which, I think most of us will agree, were, to say the least, exaggerated in an opposite direction, attributing to Canada 500,000,000 acres of profitably utilisable wheat land. Against such inflated prophecies he argued that the whole area employed in both temperate zones of the world for growing all the staple food-corps, was not more than 580,000,000 acres, and that in no country had more than 9 per cent. of the area been devoted to wheat culture. But error of estimate in one direction or another is quite inevitable when the available data on which to form a conclusion are so scanty. Replying later to journalistic criticism, Sir William, it must be remembered, acknowledged the undoubted fertility of portions of the Northwest provinces; but, basing the conclusion on official meteorological statistics and on supplementary data supplied by Mr. Wood Davis as to the July and August temperatures of these regions, he suggested that 'from one-half to one-third only' of Manitoba—the southwest portion already fully occupied—was adapted to wheat. It was doubtless in the light of these climatic records that he inclined to regard 200,000 square miles of the whole 300,000 square miles comprising Assiniboia, Alberta and Saskatchewan, as these regions were then defined, as lying 'outside the districts of profitable wheat-growing,' while even of the remainder it was apparently suggested that it would take thirty years from 1898 to place as much as 18,000,000 acres under all grain crops. Can we here to-day, with another ten

years' experience, reach a somewhat greater accuracy in this search into the possibilities before us?

As illustrating the remarkable discordance of view hitherto existing, it is well to have before us, as a starting point for debate, some specimens of later but still most widely varying estimates of the capabilities of this country. These I quote from the cautious report rendered by Professor Mavor to the British Board of Trade in 1904, midway through the decade now closing. More or less speculative as it is fully acknowledged all estimates must be which purport to define the area 'physically or economically susceptible of wheat production,' that painstaking investigator set aside, as of little value, hypothetical curves setting forth the 'northern limit of cereal production' reliable data for which 'were not forthcoming, and if they were they would be constantly changing.' After enumerating under fourteen different heads and sub-heads a formidable list of distinct but materially qualifying 'conditions' of factors covering questions of soil, of temperature, and meteorology, of moisture, sunshine, and acclimatisation of the plant, Professor Mavor suggests that, broadly speaking, the cleavage of the areas of different fertility runs obliquely from south-east to north-west through the great quadrilateral of the Canadian North-West. Alike in the north-eastern and in the south-western angle the conditions seemed to him more or less unfavourable. The south-eastern and north-western corners and the belt connecting them, however, presented relatively favourable conditions; an exception qualifying this subdivision was, however, suggested in the extreme north-west.

The vagueness of the statistical basis on which any numerical estimate of future wheat areas must rest cannot better be shown than by briefly referring to the results of five independent estimates which are quoted in this report. For the details of these estimates it is necessary to refer any student of the report to the analysis of each, differing as they do materially in their methods and in the classification of the areas comprised within the Manitoba, Assiniboia, Saskatchewan, and Alberta of that date. As regards the total area for settlement and for annual wheat-growing respectively, the first three of these estimates varied in placing the surface fit for settlement or susceptible of cultivation as low as 92,000,000 acres, and as high as 171,000,000. The annual surface available for wheat in these districts ranged from 13,750,000 acres to 42,750,000 acres, and the resultant possible produce from 254,000,000 bushels to 812,000,000 bushels.

It should be added, to make these figures clear, that all the estimators quoted assume as a condition precedent to their accomplishment such an influx of population and settlement of the country as would be adequate to secure the cultivation of the hypothetical cultivable area.

With Professor Mavor, we may think that both the lower estimates are over-cautious and the third perhaps over-sanguine, while most properly he reminds us that beyond the physical capacity of any region, the question of economic advantage remains to be solved, under what may be conditions prevalent at a distant time, what effect a rise of price might have, and whether the farmers of the future would devote so much of their land as is here suggested, and so much of their working capital, to wheat alone. I ought to add that a fourth estimate referred to in the report takes the graphic form of a map, distinguishing the suggested area where the wheat crop is certain, where less certainty exists from the effect of summer frosts, and where, again, the crop is uncertain from insufficient moisture. Yet another estimate was quoted as made in 1892, but endorsed as not over-stating possibilities of the future in July, 1904, and this classified somewhat more than half of the land of Manitoba as 'land suitable for farming,' or 23,000,000 acres, allotting to the rest of the North-West 52 000,000 acres more, or in all 75,000,000 acres. The same estimator, forecasting the results for 1912 (or three years from the present time), allotted to Manitoba a probable wheat production of 168,340,000 bushels, and to Alberta, Assiniboia, and Saskatchewan 181,600,000 bushels. This crop of 350,000,000 bushels of wheat was in addition to an estimate of a further 200,000,000 bushels of oats and 50,000,000 bushels of barley. I have little hesitation in concluding, with Professor Mavor, that such widely divergent results, arrived at, as we are told, by competent estimators, illustrated the impossibility at the time of that report of setting out precise limits of cultivation in a region in which so much has yet to be done. To-day I would ask, Has the lapse of another quinquennium, full of interesting movements in both the population and the crops of the North-West, enabled us to reach any greater certainty? If so, the opportunity of this meeting affords an occasion to submit the conclusions, optimistic or pessimistic, practical or theoretical, economic or scientific, to the test of friendly and thorough discussion.

It is a relief to turn from the perplexing variety of these speculations as to the future to the relatively more solid ground afforded by the actual records of wheat extension here. If the progress of the past, and here once again more especially of the very latest decade, is to govern the prospect of the years to some, the wheat area of Canada must possess a great expansive power.

There are defects of continuous statistics showing from year to year the total acreage of the Dominion, although the recent good work of the Census and Statistics Office promises that this will henceforth be remedied. But outside of the three great wheat-growing sections—Ontario, Manitoba and the North-West—the surface under this cereal

is not material. By the latest figures available the four Eastern Provinces do not now grow 174,000 acres collectively, while the small surface in British Columbia, not appearing in the last general Bulletin, was only 15,000 acres at the last census. In the roughly-sketched diagram I insert here*, therefore, the course of wheat-growing on 6,437,000 acres, out of the 6,611,000 accounted for in 1908 may be conveniently, if only approximately, traced.

The decline in Ontario, where as in older settlements wheat-growing shrinks as more diversified forms of agriculture evolve, is much more than compensated for when the acreage of Manitoba, and in later years the rest of the North-West, is superadded, as in the columns of this diagram, and the rapidity of the recent extension, which —had the 1909 figures reached my hands sooner would have carried the total area far beyond the seven million limit—testifies to the energy in the task of bread-raising which this hopeful section of the British Empire displays.

But whatever determinations we can reach on the hypothetical questions here propounded, whether we may regard the greater rate of wheat-field extension in the world at large which has marked the last decade as disposing of immediate alarm for the bread supply of the next generation, or whether we find in the recent whisper of augmenting prices corroboration of the gain of population on subsistence, it is clear that our statistical records require a further development and a much improved continuity, especially in the new regions of the wheat supply of the future. Nor yet, again, can we dispense with the urgent lesson that science has much to teach us in making more use than we do of the areas acknowledged to be under more or less rudimentary cultivation. If Sir William Crookes was right in adopting the American statistician's average of 12.7 bushels per acre as the mean of the recognisable wheat-fields of the world, the prospect of the extra seven bushels he sought as immediately desirable will make us eager to learn the very latest triumphs of the laboratory in winning for the soil a freer measure of the nitrogen of the air. Even here in Manitoba, where a much higher yield seems on the average to be maintained under existing conditions, and where the cultivators with their 18 bushels average start from a vastly higher level, the promise of such a scientific ally should gladden the hearts of the hard-working pioneer.

One caution, however, I feel it my duty to give, as a practical rather than a scientific agriculturist. Whatever wonders are offered in the way of manurial adjuncts or mechanical contrivances, do not let our advisers overlook the paramount consideration of the cost which

(* It has been necessary to omit the diagram from copies printed in Winnipeg).

the newer systems may involve. For the extensive farming of a young country it is above all requisite to remember that expensive methods of cultivation are not as feasible as in the intensive husbandry of old settled regions. Hopefully as we may wait on the chemist's help, I confess that, for my own part, I incline still more confidently to the botanist, under whose aegis of protection agriculture has this year been placed by the decision of the authorities. The producer of new and prolific and yet disease-resisting and frost-defying breeds of wheat plants is to-day more than ever encouraged by what has been done in many lands of late in this direction, to suit the crop to its environment. Nothing could be a greater boon to the wheat farmers, handicapped by a short and irregular supply of summer warmth, and the occasional but often untimely invasion of the frost fiend, than the production of varieties of wheat at once prolific and early ripening, and suited to the relatively scanty moisture of semi-arid regions. What success Canadian investigators, with their renowned experimental system, have had in this direction we hope to hear at Winnipeg, while some of us who have listened to Professor Biffen, of the Agricultural Department of Cambridge University, look for hopeful results from the application of Mendelian laws to the breeding of wheat.

In closing, let me add that though it is a quarter of a century since I last was here, the message I gave local agriculturists then is one I am tempted to repeat now. It is no use to treat the vast territories you have at your disposal as if they were a mere wheat mine to be exploited in all haste and without regard to its permanence and its future profitable development. It is unwise to proceed as if bread were the only item of food requiring attention at your hands, and to regard a spasmodic rush of grain for a limited number of years from a poorly tilled surface the only way to profitable returns. The stale maxim of not carrying all your eggs in one basket has a very profound truth to rest upon. The farming of the future must ultimately be one of more careful tillage, more scientific rotations, and of consideration for the changes in the grouping of population and in the world-wide conditions of man and his varying wants. What is going on all over the world has to be learned and studied well, and wheat pioneers of the North-West must not forget the possibility of yet new competitors arising in the single task of wheat-growing, whether they are to be looked for in the still developing sections of the Russian Empire and the still open levels of Argentina, the little known regions of Manchuria, the basin of the Tigris and Euphrates, the more completely irrigated plains of India, the tablelands of Central Africa, or perhaps under new conditions and a more developed control of the reserves of water supply on the southern shores of the Mediterranean or even in the long tilled valley of the Nile.